DOI: 10.1111/infa.12608

RESEARCH ARTICLE

INFANCY THE OFFICIAL JOURNAL OF THE INTERNATIONAL CONGRESS OF INFANT STUDIES WILEY

Toddlers′ prior social experience with speakers influences their word learning

Elise Breitfeld | **Anna M. Compton** | **Jenny R. Saffran**

Department of Psychology, University of Wisconsin-Madison, Madison, Wisconsin, USA

Correspondence
Elise Breitfeld, 1202 W. Johnson St., Madison, WI 53706, USA.
Email: breitfeld@wisc.edu

Funding information
University of Wisconsin-Madison Hilldale Undergraduate/Faculty Research Fellowship; National Institute of Child Health and Human Development, Grant/Award Numbers: R37HD037466, U54 HD090256

Abstract

Toddlers prefer to learn from familiar adults, particularly their caregivers, and perform better on word learning tasks when taught by caregivers than by strangers. However, it remains unclear why toddlers learn better from caregivers than from strangers. One possibility is that toddlers are more receptive to learning from individuals whom they have found to be engaging in previous interactions. The current study tested whether toddlers learn more from an unfamiliar adult who was previously engaging than from an unfamiliar adult who was previously unengaging. Toddlers (27–29 months, N = 40) were taught labels for novel objects by two different experimenters. Prior to word learning, toddlers watched pre-recorded videos of one experimenter utilizing engaging behaviors (i.e., using infant-directed speech, gestures, eye contact, and positive affect) and one experimenter utilizing unengaging behaviors (i.e., using adult-directed speech, no gestures, no eye contact, and neutral affect). Both experimenters were equally engaging during labeling. Word learning was then tested using a looking-while-listening paradigm. The results of linear mixed-effects model, cluster-based permutation, and growth curve

Elise Breitfeld and Anna M. Compton are co-first authors.

analyses suggest heightened performance for words that were taught by the experimenter who was previously engaging. These results begin to reveal the kinds of social experiences that promote success in early word learning.

1 | INTRODUCTION

As young children are acquiring language, they have the opportunity to learn from many different people in their environment. Day-long audio recordings of infants' naturalistic language input suggest that, on average, North American infants receive language input from seven different speakers each day (Bergelson et al., 2019). However, despite having access to language input from many different sources, young children may not learn words equally well from interactions with different speakers. For example, the type of speech a speaker uses can impact how well toddlers learn words from them. When words are taught using infant-directed speech (IDS), a style of speech characterized by shorter utterances, a slower rate of speech, longer pauses, and higher pitch (Cooper & Aslin, 1990; Fernald, 1989), toddlers learn better than when words are taught using adult-direct speech (ADS; Graf Estes & Hurley, 2013; Ma et al., 2011). Furthermore, corpus analyses correlating features of toddlers' naturalistic language input with their subsequent vocabulary size similarly demonstrate that the quantity of speech directed towards the child (i.e., IDS) is positively related to their later vocabulary size; however, the quantity of overheard speech (i.e., ADS) is unrelated to later vocabulary size (Shneidman et al., 2013; Weisleder & Fernald, 2013). Thus, the particular kind of language input toddlers receive from different speakers impacts their language learning success.

It has been proposed that IDS plays a central role in modulating infants' attention and promoting learning (Kitamura & Burnham, 2003). Indeed, children demonstrate a preference for and heightened attention to IDS compared to ADS (ManyBabies Consortium, 2020). Furthermore, the extent to which speakers employ IDS structures (e.g., exaggerated articulation of vowel sounds and prosody) correlates with infants' preference for IDS over ADS, along with improvements in infants' speech perception performance, suggesting that high quality IDS directs infants' attention to speech and supports their learning (Liu et al., 2003; Outters et al., 2020). This body of work, coupled with recent research demonstrating that infants show stronger time-locked neural and pupillary responses to IDS compared to ADS (Kalashnikova et al., 2018; Nencheva et al., 2021), has led developmental scientists to propose a Dynamic Attention Theory of IDS (Nencheva & Lew-Williams, 2022). This theory proposes that the mechanism underlying infants' preference for and learning from IDS is infants' ability to entrain and attend to its moment-to-moment dynamics. Importantly, this theory proposes that high quality input is not necessarily a feature of the speech itself, but is instead defined by how well the speech promotes time-locked modulations in behavior, attention, and the brain. Crucially, this theory calls for exploration of how other multimodal cues that co-occur with speech may also contribute to entrainment and attentional processes that support language learning.

Indeed, in addition to the features of speech itself, the quality of social cues provided by a speaker in tandem with language input matters for word learning success. For example, the extent to which a speaker is socially responsive to a child predicts word learning. That is, the more a speaker follows the child's attention, establishing moments of joint attention when the child and speaker are attending to the same object, and provides information about the object the child is attending to (e.g., providing a label), the more the child learns (e.g., Lucca & Wilbourn, 2019). In addition, toddlers learn words better when they are taught labels for objects belonging to categories they are interested in, such as vehicles or animals (Ackermann et al., 2020). Thus, the extent to which caregivers are attuned to what children are attending to, and their ability to capitalize on opportunities to provide input about the things children are interested in, is related to language learning success. A longitudinal study of mothers' responsiveness and toddlers' language development revealed that maternal responsiveness, measured by how frequently mothers shifted their attention to and provided input about objects their 9- to 13-month-old child was attending to during a 10-min play session, predicted their child's achievement of language milestones (Tamis-LeMonda et al., 2001). In other words, caregivers' prompt, contingent responses support successful language learning. Furthermore, the strategies that caregivers use when responding to their child can also impact language development. For example, parents' use of gestures, such as pointing and eye-gaze cues, are positively related to their child's later language learning and vocabulary growth (Rowe et al., 2008; Salo et al., 2019). Gesture accompanying language input also supports toddlers' successful word learning in lab studies (Booth et al., 2008; Cheung et al., 2021). Taken together, this body of literature has established the beneficial effect of embedding word learning moments within rich, responsive social interactions.

Similar to the proposed Dynamic Attention Theory of IDS, frameworks for understanding the role of contingent interactions in language learning also suggest an underlying attentional mechanism. Specifically, it has been proposed that contingent interactions support learning by promoting children's attention to language input (Masek et al., 2021). Additionally, emerging theories on the role of social cues in word learning suggest that they too have an attention-orienting function (Lee & Lew-Williams, 2023). Thus, these theories suggest that attention-promoting social behaviors like IDS, contingent interactions, and gestures, lay the foundation for successful word learning.

Importantly, much of this previous work has focused on how speakers' language use and social cues during word learning moments influence children's learning outcomes; however, children also interact with their social partners outside of these language learning contexts. Thus, a child's experience with a particular speaker is often not limited to that speaker's behavior during the word learning moment itself; rather, children accumulate experience with their interlocuters across different social contexts over time. For example, children observe a teacher's behavior during learning moments in class, but they also interact with that teacher outside of explicitly teaching-focused interactions. Some teachers may employ attention-promoting behaviors that support learning while they are teaching and in other interactions with children, whereas others may employ these same engaging behaviors solely while teaching, without extending them to other interactions. As such, features of children's previous experience with individuals outside of learning moments may also impact their ability to learn words from different speakers, perhaps even above and beyond the speaker's behavior during the word learning moment itself. However, limited research has investigated how speakers' behavior in previous interactions affects children's learning from them in subsequent interactions.

Existing work has largely focused on how children's familiarity with a speaker impacts their ability to learn from them. For example, 24-month-old toddlers demonstrated better word learning in a lab task when the novel words were taught to them with audio recordings of their own mother's voice compared to when they were taught with audio recordings of an unfamiliar woman's voice (van Rooijen et al., 2019). Even though both speakers used IDS, toddlers learned better from their own mother. The authors hypothesized that this effect was the result of familiarity; toddlers had previous experience listening to and learning from their mother's voice but not the unfamiliar woman's voice. Indeed, a growing body of literature suggests that children prefer to learn from and retain information better from familiar adults, like their own preschool teacher or an adult who shares their native language or accent (Corriveau & Harris, 2009; Kinzler et al., 2011). What might be driving young children's affinity for learning from familiar caregivers?

Importantly, toddlers' previous experiences with different speakers may not only vary in quantity, but also quality. In particular, the extent to which toddlers have experience with a speaker interacting in ways that are attention-grabbing and beneficial to learning—for example, using IDS, making eye contact with the child, providing input about things the child is interested in, using gestures, displaying positive affect, etc.—may influence toddlers' subsequent ability to learn from them. In other words, even when speakers utilize behaviors that promote attention and facilitate learning during a teaching moment, the nature of toddlers' previous experience with a speaker may modulate learning success. For example, suppose two teachers are equally engaging during a teaching interaction. However, if one teacher previously interacted with the child in an engaging way, while the other teacher previously interacted with the child in an unengaging way, will these differences in prior behavior impact the child's learning? To address this question, we developed a three-part task in which we manipulated the engagingness of a speaker prior to word learning.

Toddlers aged 27–29 months participated in our word learning task. At this age, toddlers have begun to display social preferences for interactional partners (Dahl et al., 2013), including a preference for learning from familiar adults (van Rooijen et al., 2019), and are skilled and efficient word learners (Bergelson, 2020; Frank et al., 2017). Toddlers first observed two speakers, one who behaved in an engaging way and another who behaved in an unengaging way. This approach allows us to equate the quantity of toddlers' previous experience with each speaker while manipulating the quality of those previous experiences (i.e., whether or not each speaker behaved in an engaging way). Toddlers then heard each speaker label novel objects. Critically, during these word learning moments, both speakers employed the same engaging behaviors (i.e., both used IDS, gestures, eye contact, and positive affect when providing labels for the novel objects). Word learning was then tested using a looking-while-listening task. Importantly, this design allows us to isolate the effect of the speakers' behavior *prior* to learning. If toddlers' word learning is only or primarily influenced by a speaker's behavior during learning moments themselves, then toddlers should learn equally well from both speakers, as they both employ learning-supportive behaviors when providing labels. However, if toddlers' learning is influenced by their experience with speakers prior to word learning, then they should learn better from the speaker who provided more engaging, higher quality input prior to word learning. We hypothesized that toddlers would learn better from the individual who had previously behaved in an engaging manner. This pattern of results would have important implications for how caregivers and teachers interact with children, even and especially outside of learning moments themselves, given that the nature of children's accumulated experience with a speaker has the potential to impact children's language learning success. Our hypothesis and analytic approach were pre-registered and can be accessed along with all stimuli, data, and analysis scripts on the Open Science Framework (https://osf.io/sdazu/).

2 | METHOD

2.1 | Participants

The final sample included 40 toddlers between 27 and 29 months old (M_{age} = 27.89 months, N = 23 female). The sample size was determined using an a priori power analysis in G*Power; based on effect sizes from studies with similar designs (Ma et al., 2011; Tsuji et al., 2021), a sample of 40 participants would provide over 90% power to detect our hypothesized effect. Three additional toddlers participated but were excluded from analysis due to fussiness and inattention to the task. Participants were recruited from the local area through an existing database of interested families. Thirty-six of the toddlers were White and four were mixed race. None of our participants identified as Hispanic. Participants were eligible if they were full-term, monolingual English-learners (i.e., had no more than 10 h/week of exposure to a language other than English) with no developmental diagnoses or history of hearing or vision problems. Two toddlers reported exposure to another language other than English for less than 10 h/week (one to Vietnamese and one to Spanish); the other 38 toddlers reported only exposure to English. The present study was conducted according to guidelines established in the Declaration of Helsinki. All parents provided written informed consent prior to participation and all experimental protocols were approved by the Institutional Review Board at the University of Wisconsin-Madison.

2.2 | Stimuli

2.2.1 | Novel objects and labels

Toddlers were taught novel labels for four novel objects selected from the Novel Object and Unusual Name Database (NOUN database; Horst & Hout, 2016). The novel objects were selected to be equally interesting and unfamiliar to toddlers, as determined by the familiarity and name-ability scores provided in the NOUN database. The novel labels were also selected from the NOUN database; all labels were monosyllabic and selected to have similar English phonotactic probabilities (Vitevitch & Luce, 2004).

2.2.2 | Pre-exposure phase

The pre-exposure phase introduced toddlers to two different experimenters: an engaging experimenter and an unengaging experimenter (see Figure 1). Both experimenters appeared together in two pre-recorded videos (a one-minute video and a thirty-second video). Toddlers watched the one-minute pre-exposure video at the beginning of the task and watched the thirty-second pre-exposure video in between blocks of the training phase. The engaging experimenter spoke using IDS, made direct eye contact with the camera, produced hand gestures, and displayed positive affect. The unengaging experimenter spoke using ADS, faced slightly off-screen without making eye contact with the camera, did not produce any hand gestures, and displayed neutral affect. Furthermore, the engaging experimenter spoke about topics interesting to toddlers (i.e., playing with toys) and the unengaging experimenter spoke about topics less interesting to toddlers (i.e., running errands). The experimenters alternated speaking and were

FIGURE 1 Examples of pre-exposure, labeling, and test trials.

matched on sex, race, age, and accent. To help toddlers distinguish between them, they were shown wearing different colored shirts and had different hair colors and styles. In addition, each experimenter always appeared on the same side of the screen throughout the study; however, which side of the screen each experimenter appeared on was counterbalanced across participants. The engagingness of the two experimenters was also counterbalanced across participants; half of the toddlers saw person A as the engaging experimenter and person B as the unengaging experimenter during the pre-exposure phase, and vice versa for the other half of the toddlers.

2.2.3 | Training phase

During the training phase, toddlers heard labels for four novel objects (see Figure 1). Each object was labeled by one of the experimenters from the Pre-exposure phase. Although one experimenter had been engaging and the other unengaging during the Pre-exposure phase, both experimenters displayed engaging behaviors during the Training phase (using IDS, smiling, looking at the camera, gesturing, etc.). On each trial, one of the experimenters pointed to an object and repeated its label four times (e.g., "Look, here's a *doff*! This is a *doff*. Wow, it's a *doff*! Cool, a *doff*!"). Assignment of objects to experimenters and the order in which the experimenters labeled the objects was counterbalanced across participants. The training phase was split into two blocks. The first block included eight trials after the first one-minute pre-exposure video and the second block included four trials after the second thirty-second pre-exposure video.

2.2.4 | Testing phase

During each test trial, toddlers saw a pair of novel objects from the training phase, one on each side of the screen, presented on a grey background (see Figure 1). Objects were yoked such that the two objects labeled by the previously engaging experimenter were always presented together and the two objects labeled by the previously unengaging experimenter were always presented together. Due to counterbalancing, this meant that each object had been trained by the previously engaging experimenter for half of the participants and by the previously unengaging experimenter for the other half of the participants. On each trial, toddlers saw a pair of objects and heard a sentence spoken using IDS that directed them to look at one of the two objects (e.g., "Find the *doff!*"). All auditory stimuli in this phase were produced by a new female native speaker of English who was different from the experimenters in the pre-exposure and training phases. Each sentence was normalized for length and intensity; each was played at an average intensity of 70 dB and lasted 5 s.

2.3 | Design & procedure

Toddlers sat in their caregiver's lap in front of a 55′ LCD screen. A camera mounted below the screen was used to record toddlers during the study so their eye movements could be manually coded. Toddlers first saw a pre-exposure video (1 minute) establishing one experimenter as engaging and the other as unengaging, followed by eight training trials (two trials labeling each of the four novel objects). Then, toddlers watched a second, shorter pre-exposure video (30 seconds) as a reminder of which experimenter was engaging and which was unengaging. Following the second pre-exposure video, toddlers saw four more training trials (one trial labeling each of the four objects). Lastly, toddlers completed the test phase. The test phase included twenty total trials (four familiar word trials and sixteen novel label trials). Two familiar word trials including words well known by toddlers at this age (i.e., "apple" and "book") were presented at the beginning of the test phase to introduce toddlers to the task. Two additional familiar word trials were interspersed throughout the test phase to maintain toddlers' interest. Of the sixteen trials testing the novel object-label pairs taught in the training phase, eight trials tested objects labeled by the previously engaging experimenter and eight trials tested objects labeled by the previously unengaging experimenter. Each object was the target object for four of the trials and the target object appeared equally often on the left and right side of the screen. Attention-getter stimuli were presented after every four trials to help reorient toddlers' attention to the task.

2.4 | Measures

2.4.1 | Gaze behavior

Participant videos were manually coded by a trained coder, frame by frame (every 33 ms) using Peyecoder (Olson et al., 2020). To assess word learning accuracy on the test trials, toddlers' fixations to the target and distractor object were examined during a critical window defined as 300–1800 ms after the onset of the target word (Fernald et al., 2008). Accuracy was calculated for each trial based on the proportion of time toddlers fixated the target objects out of the total time they spent fixating either the distractor or the target object. This measure of accuracy was used as our outcome variable of interest for all analyses to investigate whether toddlers' word learning (i.e., accuracy in identifying the target object at test) differed between object-label pairs taught by the Engaged versus Unengaged experimenter. On a given trial, toddlers who successfully learned the novel word-object pairings should look at the target object more than the distractor object during this critical window (i.e., their accuracy should be above 0.5). Videos were coded in silence such that coders were unaware of which object was the target on each trial. To measure reliability, 25% of the participant videos were independently recoded by a second coder. Coders agreed on the gaze location for 98% of all frames and agreed within one frame on 96% of all shifts in gaze.

3 | RESULTS

The main pre-registered analyses were carried out with series of linear mixed-effects models in R Studio (2023.09.1, R version 4.3.1) using the lme4 package (1.1–34). Each of these models regressed accuracy for each trial at test on condition (Engaged vs. Unengaged) to examine the condition difference in word learning accuracy as well as whether accuracy significantly differed from chance in each condition. Condition was dummy-coded (0 for one condition and 1 for the other) and accuracy was adjusted with an offset of −0.50 such that an accuracy value of 0 is equal to chance performance. All models included a by-subject random intercept and a by-subject random slope for condition (Brauer & Curtin, 2018).

We predicted that toddlers would demonstrate better learning of the words (i.e., show a higher proportion of looks towards the target object at test) that were taught by the experimenter who had previously behaved in an engaging way compared to the words that were taught by the experimenter who had previously behaved in an unengaging way. That is, we expected that accuracy on trials testing items in the Engaged condition would be higher than accuracy on trials testing items in the Unengaged condition. The results of linear mixed-effects models examining whether or not accuracy was significantly different from chance in each condition revealed that toddlers' word learning accuracy was significantly above chance in the Engaged condition, $b = 0.09$, $F(1, 38.12) = 15.99$, $p < 0.001$, but not significantly above chance in the Unengaged condition, $b = 0.03$, $F(1, 38.00) = 1.22$, $p = 0.28$. Furthermore, the within-subjects effect of condition was marginally significant, $b = 0.06$, $F(1, 38.10) = 3.63$, $p = 0.06$, providing additional, though less robust, support for our predicted effect—that toddlers demonstrate better word learning when taught by the previously engaging experimenter compared to words taught by the previously unengaging experimenter. As predicted, toddlers' average accuracy collapsed across the critical window (300–1800 ms after target word onset) was higher in the Engaged condition, $M = 0.59$, $SD = 0.13$, than in the Unengaged condition, $M = 0.53$, $SD = 0.16$ (see Figure 2).

Visual inspection of toddlers' fixations across the course of the test trials also suggests that toddlers looked more to the target object during the critical window on Engaged trials compared to Unengaged trials (see Figure 3). Thus, to further examine the effect of condition, we performed two additional exploratory analyses: a cluster-based permutation analysis and a growth curve analysis (GCA). Both of these analyses allowed us to investigate more precise temporal dynamics of the condition difference in word learning performance. As noted above, when averaged across the critical window from 300 to 1800 ms post target word onset, toddlers' accuracy was numerically higher in the Engaged condition than in the Unengaged condition; however, this difference was marginally significant when collapsed across this window. The cluster-based permutation analysis (see Maris & Oostenveld, 2007) and GCA allow us to explore how toddlers' word recognition unfolded over time in each condition, rather than collapsing performance across our critical window into an averaged accuracy measure.

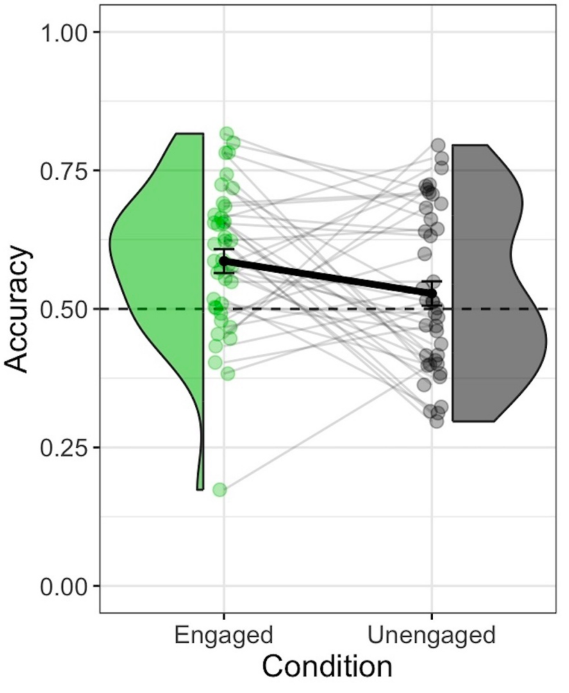

FIGURE 2 Mean accuracy (i.e., proportion of fixations to the target object) across the critical window (300–1800 ms) for each condition (in black). Individual points represent the accuracy of each participant averaged across trials in each condition (Engaged in green and Unengaged in dark gray). Lines (in light gray) link participants' responses between the two conditions. Error bars represent +/−1 standard error. The dashed horizontal line at 0.5 indicates chance performance (i.e., looking equally to the target and distractor objects).

First, a cluster-based permutation analysis was used to identify the longest continuous period of time within the critical window where accuracy was significantly different between our two conditions. This non-parametric approach provides the opportunity to analyze the temporal effects of eye-gaze data (e.g., Borovsky, 2017; Dautriche et al., 2015; Havron et al., 2019; Reuter et al., 2021; St. Pierre & Johnson, 2021). To do this, a within-subjects *t*-test is run for each 33 ms time bin (the frame rate of our eye gaze coding) within our critical window from 300 to 1800 ms. Each *t*-test calculated whether there is a significant difference in looking to the target object between the two conditions in that time bin. In other words, for each subject, within each time bin, we calculate their accuracy (i.e., looking to the target) averaged across trials in each condition. For example, for each subject, at 300 ms after target word onset, we calculated, on average, how often they were looking at the target object on Engaged trials and on Unengaged trials. We then repeated this process for each 33 ms time bin within our critical window and ran *t*-tests to compare accuracy between conditions at each time point. From these *t*-tests, we then determined the largest cluster of adjacent time bins where the effect of condition was significant ($t > 2.0$). Importantly, this criterion for including a time bin in a cluster is independent of the process for assessing the significance of the cluster and therefore does not affect our false positive rate. The largest cluster was then assigned a cluster *t*-value, equal to the sum of the *t*-values within the cluster. Then, to correct for multiple comparisons and evaluate the significance of this cluster, we determined whether the size of the largest continuous cluster of significant *t*-tests was larger than what would be expected by chance. The data was randomly

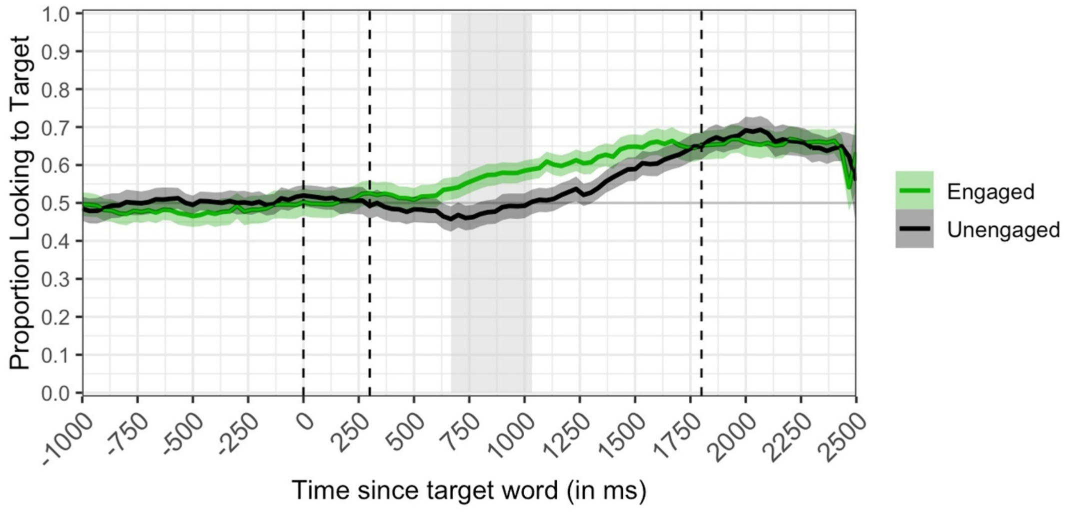

FIGURE 3 Time course of toddlers' accuracy in fixating the target object for test trials in the Engaged (in green) and Unengaged condition (in black). Solid lines represent the proportion of fixations to the target object (i.e., accuracy), averaged across participants. The ribbons around the lines represent +/−1 standard error. The horizontal line at 0.5 is chance performance. The shaded area indicates the portion of the trial (677–1033 ms) where the cluster-based permutation analysis revealed a significant effect of condition on accuracy.

reshuffled 1000 times and the largest continuous cluster of significant effects in each of the permuted data sets was identified. The proportion of these data sets with cluster *t*-values greater than the observed cluster *t*-value in the original data is represented by the *p* value for this analysis. If fewer than 5% of these permutated data sets have cluster *t*-values greater than that found in our original data set, we can conclude that the cluster is larger than what would be expected by chance. The results of the cluster-based permutation analysis revealed a significant cluster for the effect of condition on word learning accuracy in the first half of the critical window (see Figure 3), 667 ms–1033 ms after target word onset, cluster $t = 67.92$, $p = 0.05$, such that toddlers' accuracy was significantly higher on Engaged trials than Unengaged trials during this window. This result provides evidence that toddlers' accuracy on the Engaged trials was significantly higher than toddlers' accuracy on the Unengaged trials for a continuous period of time within the critical window that is longer than what would be expected by chance.

Next, the GCA approach quantifies changes in word recognition accuracy over the course of the word learning test trials to examine condition differences in the shape of the trajectory of toddlers' word recognition between our two conditions. Thus, similar to cluster-based permutation analyses, GCA allows us to analyze toddlers' dynamic eye-gaze behavior throughout our critical window, rather than collapsing across it using a measure of mean accuracy. GCA includes orthogonal polynomial time terms and interaction terms between condition and each time term; theses terms quantify different aspects of the shape of toddlers' word recognition at test and measure whether or not they differ between conditions. An intercept term quantifies the average accuracy across our critical window. A linear time term quantifies the average increase in accuracy across the critical window (i.e., the slope of the line connecting accuracy at 300 ms to accuracy at 1800 ms). A quadratic time term quantifies the steepness of the increase to peak accuracy within the critical window (a more negative value indicates a sharper inverted u-shape). And a cubic time term quantifies the asymptotes in accuracy on either end of the critical window (i.e., a delayed increase in accuracy at the onset or maintained peak accuracy at the offset of the window). Our model regresses accuracy (empirical logit transformed) on condition (centered: Unengaged coded −0.5 and Engaged coded 0.5), three centered, orthogonal polynomial time terms (linear, quadratic, and cubic), and the interaction between condition and each time term. Using GCA to model the shape of toddlers' gaze behavior on the test trials in each condition revealed a significant overall effect of condition, $b = 0.24$, $t = 2.06$, $p = 0.039$, suggesting that toddlers had overall higher accuracy in fixating the target object across our critical window on Engaged trials compared to Unengaged trials. This result provides further converging evidence for the pattern of results revealed by the linear-mixed effects model analysis and the cluster-based permutation analysis: toddlers demonstrated better learning of the words taught by the previously engaged experimenter. Furthermore, there was a marginally significant interaction between condition and the quadratic time term, $b = -0.54$, $t = 1.95$, $p = 0.051$, suggesting that toddlers' accuracy increased earlier and more quickly on Engaged trials compared to Unengaged trials (see Figure 4). This result is also consistent with the result of the cluster-based permutation analysis. Toddlers' accuracy in fixating the target object begins to increase earlier on trials in the Engaged condition compared to trials in the Unengaged condition and it is during this portion of the trial—when toddlers' accuracy has begun to increase on Engaged trials but has not yet begun to increase in the Unengaged condition—where the cluster-based permutation analysis revealed the largest cluster of continuous time bins where accuracy was significantly different between the two conditions.

Taken together, the converging pattern of results from the linear mixed-effects models, the cluster-based permutation analysis, and the GCA model are consistent with our hypothesis—toddlers demonstrated higher accuracy and more efficient recognition in identifying target words that were taught by the experimenter who had previously behaved in an engaging way compared to those taught by the experimenter who had previously behaved in an unengaging way. Even when both experimenters employed engaging behaviors during learning (i.e., both used IDS, positive affect, and gesture when teaching the novel words), toddlers demonstrated

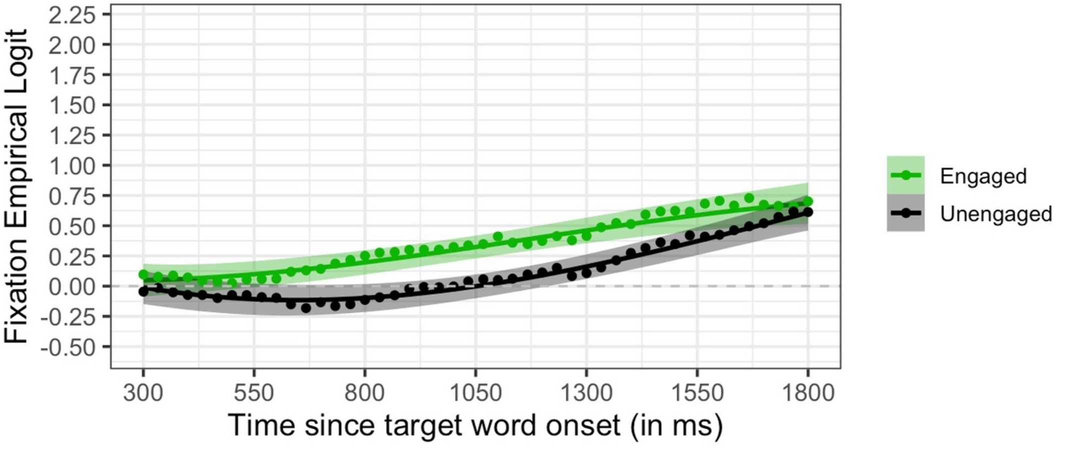

FIGURE 4 Time course of changes in toddlers' accuracy in fixating the target object over the critical window (300–1800 ms) for test trials in the Engaged (green) and Unengaged (black) conditions. Solid lines are growth curve model fits. The ribbons around the lines represent +/−1 SE. Data points are raw data average across the trials and participants for each condition and time bin (every 33 ms). The dashed horizontal line at 0 is chance performance.

better learning of the words taught by the experimenter who had behaved in a more engaging way prior to the training phase.

4 | DISCUSSION

The focus of the current study was to examine whether toddlers' novel word learning is affected by the nature of their previous experience with a speaker. Toddlers were introduced to two experimenters in pre-recorded videos; one experimenter behaved in an engaging manner (i.e., used IDS, produced gestures, looked directly at the camera, spoke about child-focused topics, and displayed positive affect) while the other experimenter behaved in an unengaging manner (i.e., used ADS, did not produce gestures, looked away from the camera, spoke about adult-focused topics, and displayed neutral affect). Then, each experimenter taught toddlers two novel words. During the word learning training videos, both experimenters were highly engaging (i.e., both used IDS, produced gestures, looked directly at the camera, and displayed positive affect). We hypothesized that toddlers' observation of the two speakers' different levels of engagement would affect subsequent novel word learning, such that toddlers would display higher word learning accuracy for words taught by the experimenter who had previously behaved in an engaging manner and lower word learning accuracy for words taught by the previously unengaging experimenter. Toddlers' eye-gaze behavior on the word learning test trials was consistent with this hypothesis. On trials testing words that were taught by the previously engaging experimenter, toddlers fixated the target object significantly above chance; however, on trials testing words that were taught by the previously unengaging experimenter, toddlers did not fixate the target object above chance. Thus, this pattern of results suggests that toddlers successfully learned the words taught by the previously engaging experimenter, but not the words taught by the previously unengaging experimenter.

Toddlers' average accuracy in fixating the target object across the critical window (300–1800 ms after target word onset) was numerically greater on Engaged trials than Unengaged trials; however, the condition difference in this measure of accuracy (collapsed across the critical window) was marginal. To examine the time course of toddlers' looking behavior, we performed two exploratory analyses: a cluster-based permutation analysis and a GCA. Both of these analyses provided converging evidence suggesting a condition difference in toddlers' gaze behavior on the test trials. Of particular interest, the GCA results revealed both a significant condition difference in average accuracy across the critical window and in the temporal dynamics of how word recognition unfolded over the course of the trial. Toddlers' accuracy in fixating the target object began to increase earlier and more quickly on Engaged trials than Unengaged trials. These data support our conclusion that previous experience with an engaging experimenter facilitated more accurate word learning.

To our knowledge, this is the first study to manipulate speaker engagement prior to a learning event. Thus, the current study provides the opportunity to evaluate the impact of toddlers' social experiences with interlocutors *prior* to a specific learning event, rather than assessing the effect of behavior *during* the learning event itself. Our results indicate that not all learning situations are created equally, and that toddlers' word learning can be impacted by their experiences with adults prior to a learning event. In particular, toddlers' previous observations of people's behavior can influence how well they learn from them. Extrapolating to more naturalistic events, toddlers may be more likely to learn words when the input is provided by someone who has previously interacted with them in an engaging and child-focused way, rather than someone who has previously interacted with them in an unengaging manner.

These results add to a growing body of literature suggesting that toddlers' previous social experiences can impact their learning. For example, toddlers' sociolinguistic environments influence what kinds of input they are able to learn from. Toddlers who spend more time around multiple adults are better able to learn words from an overhearing context: when they are listening to speech that is not directed towards them, but to a different person in their vicinity (Shneidman et al., 2009). Similarly, toddlers' previous exposure to multiple dialects is related to their ability to learn words from multi-accented input (Kartushina et al., 2021). The current study builds on this existing work to suggest that beyond the effects of broader sociolinguistic environments, toddlers' previous sociolinguistic experiences with particular individuals influences their future learning from those individuals.

In order to manipulate speaker engagingness in the current study, we bundled together a wide range of sociolinguistic behaviors, including type of speech (IDS vs. ADS), gestures, affect, eye contact, and topic of conversation. It is interesting to consider which of these manipulated behaviors impacted toddlers' subsequent word learning from the two speakers. For example, toddlers' previous experience with a speaker's speech register (IDS vs. ADS) could influence word learning more than their previous experience with a speaker's gesture use. We cannot disentangle the contribution of each of these factors in the current design; however, the current design does allow us to conclude that the observed difference in learning outcomes must be due to the speakers' behaviors *prior* to learning rather than *during* learning, given that both speakers employed engaging affective and linguistic behaviors during the word learning phase. Future studies could examine the effect of each manipulated behavior individually to determine their relative contributions to subsequent word learning performance.

Furthermore, it is possible that the reason toddlers learned better from the previously engaging experimenter is because their speech register during the word learning training phase was more similar to the speech register toddlers had previously heard this person use (i.e., the engaged experimenter spoke using IDS in both the pre-exposure phase and the training phase, while the unengaged experimenter spoke using ADS in the pre-exposure phase but switched to IDS in the training phase). Future work could investigate this possibility by having both experimenters use ADS, rather than IDS, during the training phase. If the same pattern of results were obtained (i.e., toddlers learned better from the previously engaging experimenter), this would provide additional evidence that it is the engaging nature of the experimenter's previous behavior driving our effect, not just its similarity to the speech register used during word learning.

An exciting possible mechanism underlying the demonstrated effect is related to emerging theories focused on attention-modulating effects of IDS and social contingency in language learning and development (Kitamura & Burnham, 2003; Luchkina & Xu, 2022; Tamis-LeMonda et al., 2014). Social contingency, or prompt and meaningful responses by caregivers to their child's behaviors, has been shown to support word learning as has IDS (Graf Estes & Hurley, 2013; Ma et al., 2011; Roseberry et al., 2014; Tsuji et al., 2020). It has been proposed that both IDS and social contingency support language learning by modulating young children's attention (Lee & Lew-Williams, 2023; Masek et al., 2021; Nencheva & Lew-Williams, 2022). For example, infants demonstrate more sustained attention within responsive, contingent interactions compared to non-contingent interactions (Mason et al., 2019; Miller & Gros-Louis, 2013). This type of sustained attention is known to support word learning (Yu et al., 2019). Perhaps in the current paradigm, toddlers' attention was similarly modulated as a function of the experimenters' engagingness. That is, toddlers' previous experience with the engaging experimenter heightened their attention to that experimenter during the subsequent word learning phase, facilitating learning, while toddlers' previous experience with the unengaging experimenter lessened their attention to that experimenter during word learning, hindering learning. Due to overlapping areas of interest in the training videos (i.e., the object was in front of the experimenter who was labeling it, see Figure 1), we were unable to reliably code where toddlers were looking during the training videos (i.e., at the previously engaging experimenter, the previously unengaging experimenter, or the object) to assess differences in attention during the training videos in which the previously engaging versus previously unengaging experimenter labeled the objects. However, future work can explore this possibility by measuring toddlers' attention during word learning as a function of toddlers' previous experience with a speaker.

The finding that the nature of toddlers' previous experiences with a speaker influences their learning from that speaker has important implications for toddlers' language development. There are vast individual differences in the kinds of social and linguistic experiences children accumulate across infancy and toddlerhood (Rowe & Weisleder, 2020). The way that adults interact with children can be determined by a wide variety of factors including their relationship to the child, the situational context, their mental health, the presence of other family members, their cultural community, etc. (e.g., Bergelson et al., 2019; Cristia et al., 2019; Custode & Tamis-LeMonda, 2020; Lam-Cassettari & Kohlhoff, 2020). Therefore, it is essential to better understand how these elements of variability may impact young children's language learning from different individuals. It is also important to note that the toddlers in the current sample are from a particular cultural background—a largely White, Western, upper-middle class population. Toddlers from other cultural backgrounds, where the kinds of behaviors displayed by the engaging experimenter are less typical, may not show the same pattern of results. As such, what qualifies as an individual behaving in an "engaging" way is likely culturally specific. Thus, it may be the case that the improved learning from the previously engaging experimenter cannot be attributed to any of the specific behaviors they displayed (i.e., IDS, gesture, positive affect, etc.), but instead to the fact that their behavior was similar to the ways in which toddlers' own caregivers typically interact with them.

In sum, the current study suggests that young children's sociolinguistic experiences impact their ability to learn from different speakers. In particular, toddlers learned novel words more successfully when they were taught by a speaker who had previously behaved in an engaging way as opposed to a speaker who had previously behaved in an unengaging way. Importantly, this study was able to control for speaker familiarity to examine how toddlers' word learning is influenced by the nature of the sociolinguistic experience with speakers *prior* to word learning. Toddlers had the same amount of experience with both speakers and both speakers were equally engaging during the word learning moments themselves. These findings point to the importance of examining the broader social context of young children's learning opportunities. Word learning potential is not wholly dependent on features of the word learning moment itself but is also impacted by a child's accumulated prior experiences, including their social experience with different speakers.

ACKNOWLEDGMENTS

This work was supported by grants from NICHD awarded to JRS (R37HD037466) and the Waisman Center (U54 HD090256), as well as the Hilldale Undergraduate/Faculty Research Fellowship awarded to AMC. The authors declare no conflicts of interest with regard to the funding sources for this study. We would like to thank the participating families and members of the Infant Learning Lab. In particular, we thank Courtney Snoberger, Julia Waltzman, and Dasha Yermol for their help with data collection and Ellie McIntosh and Abby Vohland for their help with stimuli creation. Special thanks to Kristin Shutts and Ron Pomper for their valuable input and discussion throughout the project.

CONFLICT OF INTEREST STATEMENT

The authors confirm that there are no interests or relationships, financial or otherwise, that might be perceived as a potential source of conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available in the Open Science Framework (OSF) at https://osf.io/sdazu/.

ORCID

Elise Breitfeld https://orcid.org/0000-0001-9941-5748

REFERENCES

Ackermann, L., Hepach, R., & Mani, N. (2020). Children learn words easier when they are interested in the category to which the word belongs. *Developmental Science*, *23*(3), e12915. https://doi.org/10.1111/desc.12915

Bergelson, E. (2020). The comprehension boost in early word learning: Older infants are better learners. *Child Development Perspectives*, *14*(3), 142–149. https://doi.org/10.1111/cdep.12373

Bergelson, E., Amatuni, A., Dailey, S., Koorathota, S., & Tor, S. (2019). Day by day, hour by hour: Naturalistic language input to infants. *Developmental Science*, *22*(1), e12715. https://doi.org/10.1111/desc.12715

Booth, A. E., McGregor, K. K., & Rohlfing, K. J. (2008). Socio-pragmatics and attention: Contributions to gesturally guided word learning in toddlers. *Language Learning and Development*, *4*(3), 179–202. https://doi.org/10.1080/15475440802143091

Borovsky, A. (2017). The amount and structure of prior event experience affects anticipatory sentence interpretation. *Language, Cognition and Neuroscience*, *32*(2), 190–204. https://doi.org/10.1080/23273798.2016.1238494

Brauer, M., & Curtin, J. J. (2018). Linear mixed-effects models and the analysis of nonindependent data: A unified framework to analyze categorical and continuous independent variables that vary within-subjects and/or within-items. *Psychological Methods*, *23*(3), 389–411. https://doi.org/10.1037/met0000159

Cheung, R. W., Hartley, C., & Monaghan, P. (2021). Caregivers use gesture contingently to support word learning. *Developmental Science*, *24*(4), e13098. https://doi.org/10.1111/desc.13098

Cooper, R. P., & Aslin, R. N. (1990). Preference for infant-directed speech in the first month after birth. *Child Development*, *61*(5), 1584–1595. https://doi.org/10.1111/j.1467-8624.1990.tb02885.x

Corriveau, K., & Harris, P. L. (2009). Choosing your informant: Weighing familiarity and recent accuracy. *Developmental Science*, *12*(3), 426–437. https://doi.org/10.1111/j.1467-7687.2008.00792.x

Cristia, A., Dupoux, E., Gurven, M., & Stieglitz, J. (2019). Child-directed speech is infrequent in a forager-farmer population: A time allocation study. *Child Development*, *90*(3), 759–773. https://doi.org/10.1111/cdev.12974

Custode, S. A., & Tamis-LeMonda, C. (2020). Cracking the code: Social and contextual cues to language input in the home environment. *Infancy*, *25*(6), 809–826. https://doi.org/10.1111/infa.12361

Dahl, A., Schuck, R. K., & Campos, J. J. (2013). Do young toddlers act on their social preferences? *Developmental Psychology*, *49*(10), 1964–1970. https://doi.org/10.1037/a0031460

Dautriche, I., Swingley, D., & Christophe, A. (2015). Learning novel phonological neighbors: Syntactic category matters. *Cognition*, *143*, 77–86. https://doi.org/10.1016/j.cognition.2015.06.003

Fernald, A. (1989). Intonation and communicative intent in mothers' speech to infants: Is the melody the message? *Child Development*, *60*(6), 1497–1510. https://doi.org/10.2307/1130938

Fernald, A., Zangl, R., Portillo, A. L., & Marchman, V. A. (2008). Looking while listening: Using eye movements tomonitor spoken language comprehension by infants andyoung children. In I. Sekerina, E. M. Fernández & H. Clahsen (Eds.), *Developmental psycholinguistics: On-line methods inchildren's language processing* (pp. 97–135). John Benjamins.

Frank, M. C., Alcock, K. J., Arias-Trejo, N., Aschersleben, G., Baldwin, D., Barbu, S., Bergelson, E., Bergmann, C., Black, A. K., Blything, R., Böhland, M. P., Bolitho, P., Borovsky, A., Brady, S. M., Braun, B., Brown, A., Byers-Heinlein, K., Campbell, L. E., Cashon, C., ..., & Soderstrom, M. (2020). Quantifying sources of variability in infancy research using the infant-directed-speech preference. *Advances in Methods and Practices in Psychological Science*, *3*(1), 24–52. https://doi.org/10.1177/2515245919900809

Frank, M. C., Braginsky, M., Yurovsky, D., & Marchman, V. A. (2017). Wordbank: An open repository for developmental vocabulary data. *Journal of Child Language*, *44*(3), 677–694. https://doi.org/10.1017/S0305000916000209

Graf Estes, K., & Hurley, K. (2013). Infant-directed prosody helps infants map sounds to meanings. *Infancy*, *18*(5), 797–824. https://doi.org/10.1111/infa.12006

Havron, N., de Carvalho, A., Fiévet, A. C., & Christophe, A. (2019). Three-to four-year-old children rapidly adapt their predictions and use them to learn novel word meanings. *Child Development*, *90*(1), 82–90. https://doi.org/10.1111/cdev.13113

Horst, J. S., & Hout, M. C. (2016). The novel object and unusual name (NOUN) database: A collection of novel images for use in experimental research. *Behavior Research Methods*, *48*(4), 1393–1409. https://doi.org/10.3758/s13428-015-0647-3

Kalashnikova, M., Peter, V., Di Liberto, G. M., Lalor, E. C., & Burnham, D. (2018). Infant-directed speech facilitates seven-month-old infants' cortical tracking of speech. *Scientific Reports*, *8*(1), 13745. https://doi.org/10.1038/s41598-018-32150-6

Kartushina, N., Rosslund, A., & Mayor, J. (2021). Toddlers raised in multi-dialectal families learn words better in accented speech than those raised in monodialectal families. *Journal of Child Language*, *49*(6), 1093–1118. https://doi.org/10.1017/S0305000921000520

Kinzler, K. D., Corriveau, K. H., & Harris, P. L. (2011). Children's selective trust in native-accented speakers. *Developmental Science*, *14*(1), 106–111. https://doi.org/10.1111/j.1467-7687.2010.00965.x

Kitamura, C., & Burnham, D. (2003). Pitch and communicative intent in mother's speech: Adjustments for age and sex in the first year. *Infancy*, *4*(1), 85–110. https://doi.org/10.1207/S15327078IN0401_5

Lam-Cassettari, C., & Kohlhoff, J. (2020). Effect of maternal depression on infant-directed speech to prelinguistic infants: Implications for language development. *PLoS One*, *15*(7), e0236787. https://doi.org/10.1371/journal.pone.0236787

Lee, C., & Lew-Williams, C. (2023). The dynamic functions of social cues during children's word learning. *Infant and Child Development*, *32*(1), e2372. https://doi.org/10.1002/icd.2372

Liu, H.-M., Kuhl, P. K., & Tsao, F.-M. (2003). An association between mothers' speech clarity and infants' speech discrimination skills. *Developmental Science*, *6*(3), F1–F10. https://doi.org/10.1111/1467-7687.00275

Lucca, K., & Wilbourn, M. P. (2019). The what and the how: Information-seeking pointing gestures facilitate learning labels and functions. *Journal of Experimental Child Psychology*, *178*, 417–436. https://doi.org/10.1016/j.jecp.2018.08.003

Luchkina, E., & Xu, F. (2022). From social contingency to verbal reference: A constructivist hypothesis. *Psychological Review*, *129*(4), 890–909. https://doi.org/10.1037/rev0000320

Ma, W., Golinkoff, R. M., Houston, D., & Hirsh-Pasek, K. (2011). Word learning in infant- and adult-directed speech. *Language Learning and Development*, *7*(3), 185–201. https://doi.org/10.1080/15475441.2011.579839

Maris, E., & Oostenveld, R. (2007). Nonparametric statistical testing of EEG- and MEG-data. *Journal of Neuroscience Methods*, *164*(1), 177–190. https://doi.org/10.1016/j.jneumeth.2007.03.024

Masek, L. R., McMillan, B. T. M., Paterson, S. J., Tamis-LeMonda, C. S., Golinkoff, R. M., & Hirsh-Pasek, K. (2021). Where language meets attention: How contingent interactions promote learning. *Developmental Review*, *60*, 100961. https://doi.org/10.1016/j.dr.2021.100961

Mason, G. M., Kirkpatrick, F., Schwade, J. A., & Goldstein, M. H. (2019). The role of dyadic coordination in organizing visual attention in 5-month-old infants. *Infancy*, *24*(2), 162–186. https://doi.org/10.1111/infa.12255

Miller, J. L., & Gros-Louis, J. (2013). Socially guided attention influences infants' communicative behavior. *Infant Behavior and Development*, *36*(4), 627–634. https://doi.org/10.1016/j.infbeh.2013.06.010

Nencheva, M. L., & Lew-Williams, C. (2022). Understanding why infant-directed speech supports learning: A dynamic attention perspective. *Developmental Review*, *66*, 101047. https://doi.org/10.1016/j.dr.2022.101047

Nencheva, M. L., Piazza, E. A., & Lew-Williams, C. (2021). The moment-to-moment pitch dynamics of child-directed speech shape toddlers' attention and learning. *Developmental Science*, *24*(1), e12997. https://doi.org/10.1111/desc.12997

Olson, R. H., Pomper, R., Potter, C. E., Hay, J. F., Saffran, J. R., Ellis Weismer, S., & Lew-Williams, C. (2020). Peyecoder: An open-source program for coding eye movements. [Computer software]. Zenodo. https://doi.org/10.5281/zenodo.3939234

Outters, V., Schreiner, M. S., Behne, T., & Mani, N. (2020). Maternal input and infants' response to infant-directed speech. *Infancy*, *25*(4), 478–499. https://doi.org/10.1111/infa.12334

Reuter, T., Dalawella, K., & Lew-Williams, C. (2021). Adults and children predict in complex and variable referential contexts. *Language, Cognition and Neuroscience*, *36*(4), 474–490. https://doi.org/10.1080/23273798.2020.1839665

Roseberry, S., Hirsh-Pasek, K., & Golinkoff, R. M. (2014). Skype Me! Socially contingent interactions help toddlers lean language. *Child Development*, *85*(3), 956–970. https://doi.org/10.1111/cdev.12166

Rowe, M. L., Özçalışkan, Ş., & Goldin-Meadow, S. (2008). Learning words by hand: Gesture's role in predicting vocabulary development. *First Language*, *28*(2), 182–199. https://doi.org/10.1177/0142723707088310

Rowe, M. L., & Weisleder, A. (2020). Language development in context. *Annual Review of Developmental Psychology*, *2*(1), 201–223. https://doi.org/10.1146/annurev-devpsych-042220-121816

Salo, V. C., Reeb-Sutherland, B., Frenkel, T. I., Bowman, L. C., & Rowe, M. L. (2019). Does intention matter? Relations between parent pointing, infant pointing, and developing language ability. *Journal of Cognition and Development*, *20*(5), 635–655. https://doi.org/10.1080/15248372.2019.1648266

Shneidman, L. A., Arroyo, M. E., Levine, S. C., & Goldin-Meadow, S. (2013). What counts as effective input for word learning? *Journal of Child Language*, *40*(3), 672–686. https://doi.org/10.1017/S0305000912000141

Shneidman, L. A., Buresh, J. S., Shimpi, P. M., Knight-Schwarz, J., & Woodward, A. L. (2009). Social experience, social attention and word learning in an overhearing paradigm. *Language Learning and Development*, *5*(4), 266–281. https://doi.org/10.1080/15475440903001115

St. Pierre, T., & Johnson, E. K. (2021). Looking for wugs in all the right places: Children's use of prepositions in word learning. *Cognitive Science*, *45*(8), e13028. https://doi.org/10.1111/cogs.13028

Tamis-LeMonda, C. S., Bornstein, M. H., & Baumwell, L. (2001). Maternal responsiveness and children's achievement of language milestones. *Child Development*, *72*(3), 748–767. https://doi.org/10.1111/1467-8624.00313

Tamis-LeMonda, C. S., Kuchirko, Y., & Song, L. (2014). Why is infant language learning facilitated by parental responsiveness? *Current Directions in Psychological Science*, *23*(2), 121–126. https://doi.org/10.1177/0963721414522813

Tsuji, S., Fiévét, A.-C., & Cristia, A. (2021). Toddler word learning from contingent screens with and without human presence. *Infant Behavior and Development*, *63*, 101553. https://doi.org/10.1016/j.infbeh.2021.101553

Tsuji, S., Jincho, N., Mazuka, R., & Cristia, A. (2020). Communicative cues in the absence of a human interaction partner enhance 12-month-old infants' word learning. *Journal of Experimental Child Psychology*, *191*, 104740. https://doi.org/10.1016/j.jecp.2019.104740

van Rooijen, R., Bekkers, E., & Junge, C. (2019). Beneficial effects of the mother's voice on infants' novel word learning. *Infancy*, *24*(6), 838–856. https://doi.org/10.1111/infa.12312

Vitevitch, M. S., & Luce, P. A. (2004). A Web-based interface to calculate phonotactic probability for words and nonwords in English. *Behavior Research Methods, Instruments, and Computers*, *36*(3), 481–487. https://doi.org/10.3758/bf03195594

Weisleder, A., & Fernald, A. (2013). Talking to children matters: Early language experience strengthens processing and builds vocabulary. *Psychological Science*, *24*(11), 2143–2152. https://doi.org/10.1177/0956797613488145

Yu, C., Suanda, S. H., & Smith, L. B. (2019). Infant sustained attention but not joint attention to objects at 9 months predicts vocabulary at 12 and 15 months. *Developmental Science*, *22*(1). https://doi.org/10.1111/desc.12735

How to cite this article: Breitfeld, E., Compton, A. M., & Saffran, J. R. (2024). Toddlers' prior social experience with speakers influences their word learning. *Infancy*, *29*(5), 771–788. https://doi.org/10.1111/infa.12608